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ABSTRACT

In the preparation of mathematics teachers both similarities and differences exist between the United States and the USSR. The vast majority of mathematics graduates in the USSR are females, primarily because most mathematics graduates will become teachers and most males do not want to teach because of low salaries and lack of respect for teachers. This problem is shared by the U.S. In the USSR, mathematics majors will take approximately 146 U.S. credit hours of mathematics during their 5-year program as compared to 45-50 credits at U.S. institutions. General education receives a great deal of emphasis in U.S. schools, whereas in Soviet schools very little, if any, emphasis is placed on general education since so much is done at earlier levels. It is apparent that Soviet educators in grades 1-10 are better prepared in mathematics than their American counterparts. This lack of preparation of U.S. teachers could be one of the factors which leads to the discouraging comparisons as between the achievement of American students and students of other nationalities. (JD)

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Mathematics Teacher Preparation: USA versus USSR

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Several disparities exist between mathematics teacher preparation in the United States (US) and the Union of Soviet Socialist Republics (USSR). This article will provide some insight into the similarities and differences in the preparation of mathematics teachers between the two countries and will provide an indepth look at what is done at one Soviet university, Simferopol State University (SSU). It is very difficult to make definitive statements about the Soviet educational system due to the shortness of the visits, a lack of hard copies on policies and curricula, and the language barrier. The information in this article is an outgrowth of three trips made to the USSR for the purpose of studying its educational system. The trips were taken in March, 1985; May, 1986; and April, 1988. Formal school visits were made to kindergartens (child care centers), 10-year general schools, a school for gifted mathematics/physics students, vocational schools and universities. Informal talks and round table discussions were held with Soviet mathematicians, educators and students. Ongoing correspondence with Soviet colleagues and students has also been

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incorporated into this article. 1

Recent studies (Evans, Ferrucci, and Cyr, 1986; Ware and Litwiller, 1986) indicate that all Soviet students are being exposed to more sophisticated mathematics and at an earlier age than American students. Current research reports and papers (National Research Council, 1989; Commission on Standards for School Mathematics, 1987; Evans, Ferrucci, and Cyr, 1986; Stevenson, Shin-ying, and Stigler, 1986; Crosswhite, Dossey, Swafford, McKnight, and Cooney, 1985; Wirszup, 1984; National Science Board, 1983) highlight the need for the US mathematics curriculum to be strengthened and/or for more comprehensive teacher training programs to be developed.

American Education

The era of the 1940's through the early 1970's in American education saw an emergence of programs oriented to a changing society. These programs which involved new approaches to learning such as individualized instruction, open schools, programmed instruction, diagnostic-prescriptive teaching, and computer assisted instruction (Holden, 1989; Underhill, 1987; Mcgettrick, 1979; West, 1977) possessed a willingness to experiment with alternatives to traditional schooling. From the late fifties through the early seventies there were many federally-funded teacher institutes in mathematics and science. The late seventies were characterized by a "Back-to-Basics" Movement (National Advisory Committee on Mathematics Education, 1975).

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Pedagogical aspects of education such as learning disabilities, multicultural education and the use of technology in the classroom have received a great deal of emphasis (Tally-Foos, 1989; Bitter, 1989; Garcia, 1988; Presmeg, 1989, Hudson, 1987; Yao, 1984). Thus, teacher-training both preservice and in-service, has stressed pedagogical aspects of education, perhaps at the expense of content training.

The undergraduate education of teachers has been and still remains the province of the colleges and universities (National Council of Teachers of Mathematics, 1981; Aichele, 1978). However, accrediting agenci[illegible]state, regional and national, have tremendous influence on the [illegible]icula of preservice teachers. Visitations from the National Council for Accreditation of Teacher Education (NCATE) also help to ensure a consistent investigation of these curricula (Aichele, 1978). In-service teacher education over the past 15 years has moved away from college and university courses to local workshops and staff development courses (Evans, 1981). Frequently, these workshops and courses have concentrated on the social problems of the eighties: drug and alcohol abuse, teenage sex, AIDS, divorce, single parent homes, etc. In contrast, Soviet teacher education, at the undergraduate level and beyond, has emphasized the academic discipline.

Soviet Education

In 1988 the USSR extended its compulsory schooling from 10 to 11 years without adding to the curriculum. This was accomplished by having children begin school a year earlier at age six. The Soviet

Ministry of Education apparently felt that covering the curriculum in 10 years was too demanding. Teachers in grades 4 through 10 specialize in the discipline they teach. (For further information about Soviet education see Evans, Ferrucci, and Cyr 1986).

Approximately one-third of all Soviet students graduating from the tenth grade will go to one of the 900 institutes of higher learning. Lisovsky (1983) states that enrollment is limited because "the number of mental workers (needed by the Soviet economy) constitutes about 12% of its able-bodied population." (p. 25) The costs for higher education is borne by the Soviet government and students are given stipends, which vary according to their scholarship and attendance at these institutions. The choice of one's major is dictated by the student's entrance examination scores, past grades, the country's needs, previous work in a related field, and at time, political factors.

At SSU there are 150 mathematics majors per year. After five years of rigorous training, approximately 115 of them will graduate and the majority of them will become teachers (Ferrucci, Evans, and Anashkin, 1990). At a meeting (April, 1988) with the Deans of the Mathematics Faculty, a concern was expressed with the preparation of incoming mathematics majors. They felt students should be better prepared to undertake the demanding curriculum which would follow. This is a concern which is shared by many US educators as well (Commission on Standards for School Mathematics, 1987; Mathematical Sciences Education Board, 1986; Travers and McKnight, 1985; National Science Board, 1983; Wirszup, 1981; Romberg, 1981).

An interesting fact about the 115 mathematics graduates in 1988 from SSU was that NOT ONE OF THEM WAS A MALE! In fact, the vast majority of all students in mathematics are females. The primary reason given as to why most mathematics majors were females was that most mathematics graduates will become teachers and most males do not want to teach because of the low salaries and lack of respect for teachers. The low salaries and low esteem of teachers is considered to be a problem shared in the US (Hounshell and Griffin, 1989; Zabel and White, 1988; Robinson, 1988). Currently in the USSR most male-oriented students are opting to major in other areas such as history, geography, physics, and physical education. A similar disinterest in mathematics on the part of American students is a concern of professional mathematicians in the US (Van, 1987).

Mathematics classes are usually taught in pairs; a lecture followed by a small group session. The courses taken by mathematics majors follow a curriculum established by the Ministry of Education. Thus, there is no choice of the courses taken; all 100-150 students in a class take the lecture at the same time. A small group session, like the lecture, lasts 45 minutes and is called a "practical hour." Each 45 minute session constitutes an "hour" of class time. Many of these smaller sessions are handled by graduate assistants. The number of lecture hours does not always equal the number of practical hours, and in fact, it usually exceeds it.

It is difficult to indicate the number of credits of mathematics students take due to the differences in the way courses are taught and in the lengths of classes. Consider a course taught for 68 hours. Since each session is 45 minutes, it is actually 68 x (3/4) = 51 clock

hours. Thus, if 24 of these hours are practical hours, then two of these ought to constitute one class hour. Therefore, we have 27 + (1/2)(24) = 39 hours, which is approximately equal to a three credit course.

Based upon the figures we received and the above analysis, it appears that mathematics majors will take approximately 146 US credit hours of mathematics during their five year span as compared to 45-60 credits at US institutions! A list of the courses, number of hours studied, the year each course is taken, and the approximation of US credit hours is given in Table 1.

In the second and third years, preservice teachers have "passive practice". That is, they observe in schools for two weeks, but do not teach lessons. In the fourth year preservice teachers intern for one month and in the fifth year they intern for an additional three years. Students must also participate in the Pioneer Camps (similar to Scout camps) in the summer as instructors.

The students graduating from SSU usually teach in grades 8 through 10. However, when needed they may be assigned to teach mathematics in any grade 4 through 10. In most states in the US, teachers certified at the secondary level are allowed to teach mathematics in a middle school (grades 5 through 8) (McEwin, 1983).

In the USSR each semester is about 16-17 weeks long not including days scheduled for final examinations compared to 14-15 weeks in the US including final examination days. In the first semester Soviet classes begin in September and finish at the end of December. Final examinations are administered in January. Second semester begins in early February and ends in late May with final examinations given in

TABLE I

MATHEMATICS REQUIREMENTS FOR SOVIET TEACHERS IN GRADES 4-10 (5-11)

Year Taken	Course	Number of Hours	Approximate Credit Hours
1	Mathematical Logic	68	3
1	Analytic Geometry	140	6
1	Algebra (Linear & Abstract)	276	12
1 & 2	Math Analysis (Calculus)	500	21
1 & 2	Computers	140	6
2	Differential Geometry	68	3
2	Topology	72	3
2	Differential Equations	174	7
2	Theory of Probability	106	5
2 & 3	Functional Analysis	212	9
3	Math Physics	123	6
3	Functions of Complex Variables	105	5
3	History of Mathematics	68	3
3 & 4	Numerical Mathematics	212	9
3 & 4	Physics	178	7
4	Methods of Optimization	102	5
4	Automatic Systems of Managing	51	3
4	Operations Research	68	3
4	Theoretical Mechanics	157	6
	Special Courses Theory of Stability Theory of Oscillations Asymptotic Methods	550	24

Total US Credit Hours = 146

June. Students attend classes six days a week for 5-6 hours for a total of approximately 30 hours per week. Since they attend school for five years, they are in class more than double the time of US students receiving similar degrees!

General education receives a great deal of emphasis in US schools, whereas in Soviet schools very little, if any, emphasis is placed on general education since so much is done at earlier levels (Heller, 1988; Galambos, 1986; Zingg, 1984; Mayhew, 1984, Scully, 1984). Soviet students start studying a foreign language and its associated culture by the fourth grade. Reading, music and dancing are also emphasized.

There are approximately 150 institutions of higher education in the USSR that train teachers of primary schools. These teachers take approximately 30 hours of mathematics as undergraduates, about seven US credits hours of mathematics methods, and several psychology courses dealing with human development. Mathematics topics covered include set theory, number systems and operations, algebra, elements of analysis, geometry, theory of quantity and measurement, and functions and relations. Upon graduation there is a state examination on the methods of teaching and the mathematics content. This training is comparable to that of preservice elementary school teachers in the US minoring in mathematics. Most of the institutions for elementary school teacher training in the US require at most one or two courses in mathematics while many do not require any mathematics methods courses at all. As of 1988, forty-four states have teacher examinations for certification (Rudner, 1988). Recertification in the

US varies from state to state and is often not associated with colleges and universities (Evans, 1981).

Teachers in grades 1 through 10 in the USSR must attend one month of retraining every five years at institutions of higher education. Teachers in grades 4 through 10 will study 60 hours of general topics and 80 hours of mathematics. They cover such topics as functions, graphing and analytical geometry. These retraining programs are usually conducted by the Regional Council of People's Deputies for each republic and not by the local universities. Teachers receive copies of Primary School, Math in School, People's Education, and Soviet Pedagogics. Each school district has a methodological research center with a pedagogical expert in each discipline. Due to escalating membership costs for professional organizations many US mathematics teachers do not have access to such journals as Arithmetic Teacher, Mathematics Teacher, School Science and Mathematics and Journal of Research in Mathematics Education.

From the above, it is apparent that Soviet educators in grades 1 through 10 are better prepared in mathematics than their American counterparts. This lack of preparation of US teachers could be one of the factors which leads to the discouraging comparisons in achievement of American students and students of other nationalities (Crosswhite, Dossey, Swafford, McKnight, and Cooney, 1985; Stigler, Shin-ying and Stevenson, 1987; NCTM News Bulletin, 1984-1988). However, to say that this is the only reason for the poor results of American students would be an over-simplification of a very complex problem.

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